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1/77

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2. Patent application number *(The Patent Office will fill in this part)* 0224356.6

21 OCT 2002

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

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Patents ADP number *(if you know it)* 6297261002

If the applicant is a corporate body, give the country/state of its incorporation

4. Title of the invention

PUTTER - HEADS

5. Name of your agent *(if you have one)*

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

GRAHAM F COLES
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BEACONSFIELD
BUCKINGHAMSHIRE HP9 1SZ

see 51/7
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Patents ADP number *(if you know it)* 4361556001

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Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

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Number of earlier application	Date of filing *(day / month / year)*

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Description 11

Claim(s)

Abstract

Drawing(s) 2 + 2

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Priority documents

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Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*

Request for preliminary examination and search *(Patents Form 9/77)*

Request for substantive examination *(Patents Form 10/77)*

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11. I/We request the grant of a patent on the basis of this application.

Signature Norman M. Lindsay Date 18 OCT 2002

12. Name and daytime telephone number of person to contact in the United Kingdom NORMAN LINDSAY 01494 725000

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Putter-Heads

This invention relates to putter-heads.

The invention relates to putter-heads and is concerned especially with improvement to the construction of putter-heads for imparting topspin to a golf ball at impact.

In putting a golf ball, it is desirable to impart forward rolling spin or topspin to the ball during the putting stroke. Topspin reduces ball skid on the putting surface and helps to initiate pure rolling motion. Imparted topspin is defined as the component of ball spin about a horizontal axis parallel to a putter impact-face imparted at impact by a putter such that the ball peripheral speed on the top surface of the ball exceeds its linear or translational speed.

It is one of the objects of the present invention to provide an improved putter-head for imparting topspin to a golf ball at impact.

According to one aspect of the present invention there is provided a putter-head wherein parameters of the head and impact-face related to imparted spin have values within predetermined limits such as to provide imparted topspin for all impacts off the putter impact-face during normal putting.

The putter-head may have a convex curved impact face with axes of curvature substantially parallel to its heel-toe axis, and may in the context of having a mass of M kilograms, centre of mass p millimetres behind the impact face and h_c millimetres above the bottom of the putter-head, a radius of gyration K millimetres about the heel-toe axis through the putter-head centre of mass and impact-face loft angle α_i degrees, where α_i is a function of impact

height h_i millimetres above the bottom of the putter-head, have positive spin rate S for all values of h_i above 5 millimetres,

where:

$$S = S_L + S_G \quad (1)$$

$$S_L = \frac{0.76 \times (-\alpha_i)}{1 + 0.04 \times (p/K)^2} \quad (2)$$

$$S_G = \frac{250 \times p \times h}{(3.2 + 70 \times M) \times K^2 + p^2} \quad (3)$$

$$h = h_i - h_c - p \times \sin(\alpha_i) \quad (4)$$

Furthermore, the minimum value of S for impact heights h_i may be +2.5 or more preferably +5.0 for values of h_i above 5 millimetres, or more preferably +2.5 or +5.0 for all values of h_i. For preference, the height h_c may be less than 10 millimetres, or, more preferably, not more than 7 millimetres. For preference, the minimum value of α_i may be -15 but preferably no less than -10.

For preference a putter-head according to the invention is provided with shaft attachment means wherein the axis of said shaft attachment means is horizontally displaced d millimetres either side of the horizontal heel-toe axis through the centre of mass. Also, the shaft-to-putter-head interface (i.e. the top of the bonded or otherwise attached section in the putter-head) is vertically displaced $d2$ millimetres above this axis. To optimise the imparted topspin properties of the assembled putter, d should be ideally zero or less than r, where r is the radius of the

putter shaft and *d2* should be negative, but this ideal is often not practical or conflicts with other design requirements. In practice the ratio *d/K* may advantageously be less than +1.0 but more preferably less than +0.33. Similarly, the ratio *d2/K* may advantageously be less than +1.0 but more preferably less than +0.33. It is also advantageous that the displacement, measured in any direction, of the said shaft attachment means from the putter-head centre of mass is less than *K*.

A putter-head in accordance with the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figures 1 to 3 are front-elevation, rear-elevation and plan view respectively of a putter-head according to the invention;

Figure 4 is a sectional side-elevation of the putter-head taken on the line I-I of Figure 3; and

Figures 5a and 5b show two diagrammatic views of the centre section of the putter-head of Figures 1 to 4 and a golf ball at two different instances of impact.

Referring to Figures 1 to 4, the putter-head 1, comprises a low-density rigid insert 2 and a high-density base 3. The base 3 forms the greater part of the putter head including the heel 4, the toe 5 the sole 6 and the shaft hosel 7. The insert 2 is bonded or otherwise fixed to the base 3 and forms a rigid interface between the impact face 8 and the base.

The insert 2 is preferably made from aluminium or magnesium alloy or a high modulus composite. Titanium alloy or other high modulus medium-low-density alloy may be used where impact-face grooves or ridges are provided, requiring

harder, higher impact strength compared to aluminium or the like. In this case, the insert can have reduced cross-section (to maintain low mass) but have the same outer dimensions. The main requirement is that the insert 2 provides a rigid interface between a golf ball and the base 3 at impact. In an alternative embodiment, the impact-face 6 can have an outer layer or an additional insert of softer material to reduce impact vibration and noise intensity (giving a so-called 'soft-feel') but it is disadvantageous to have the entire structure of the insert in soft material as this reduces topspin imparted by vertical gear-effect.

The rear portion of the insert is a close fit in a recess on the front upper part of the base 3. This arrangement serves to displace high-density material from the front and upper part of the base and so moves the centre of mass of the putter-head nearer the sole 6 and further back from the impact-face 8. A further means of displacing the centre of mass vertically downwards and horizontally rearwards is provided by removing part of the top front corner of the base to form a sunken shoulder 9. The shoulder 9 may be offset from the top surface 10 of the base by approximately constant amount (as shown in Figure 1) or may be flat-topped. For stylistic purposes, the depth of the shoulder (horizontally into the base) may equal the depth of the insert. Otherwise the depth differs from that of the insert and may be in the range 5 to 20 millimetres, but preferably in the range 10 to 15 millimetres.

Preferably the forward part of the base extends between the heel and toe ends, or nearly so, such that the overall shape of the front part of the putter-head is quasi-rectangular in plan view but has centre of mass height of less than 6 millimetres or even less than 5 millimetres. This arrangement partly maintains the appearance of conventional styled putters where the impact face typically extends most of the length of a putter-head, but also

assists the aims of the invention to reduce the height of the overall centre of mass (when combined with the insert 2 and the remainder of the base) to less than 10 millimetres or more preferably not greater than 7 millimetres. For this purpose it is useful to make the height of the shoulder at least equal to the overall putter-head centre of mass (except in the region below the insert 2 where it is lower to accommodate the insert).

For the purpose of further description of the present invention, reference will be made to Figures 5a and 5b, which show diagrammatic views of the centre section of the putter-head of Figures 1 to 4 at two different instants of impact with a golf ball 13 resting on a putting surface 14. By way of illustration, the centre of mass 15 of the head 1 is shown located at height h_C millimetres above the sole 6 and at distance p millimetres behind the impact-face. In Figure 5a the centre of impact (a playing variable with random error) is identified as being at a height h_a millimetres above the sole 6 and in Figure 5b the centre of impact is at height h_b millimetres above the sole.

For convenience, the profile of the impact-face 8 is shown with exaggerated convex form in Figures 5a and 5b. In this illustration, the upper half 16 of the impact-face is flat and inclined with loft angle α_{MAX}, and is tangential to the convex curved lower half 17, where the loft angle gradually reduces from α_{MAX}, through zero to a maximum negative value at the lowest point on the impact-face. In general any suitable smooth (i.e. not abrupt) convex profile may be used, where the impact-face loft angle reduces from a maximum value (which may be positive or zero) at the uppermost part of the impact-face to a minimum value, which is always negative, at the bottom of the impact-face. The profile being generally curved in one plane only such that

the axis or axes of curvature are parallel to the putter-head heel-toe axis.

The main effect required of the impact is to launch the golf ball 13 with linear velocity substantially along the intended line of putt and preferably with a slight positive (upward) elevation angle. The upward trajectory is often provided by a small amount of loft (typically +3 degrees) on the impact-face of a putter. Moreover, most golfers adopt an approximate 'pendulum swing' in putting where the putter-head is swung about a substantially horizontal axis with the swing rotation axis and the putter shaft axis in the same plane (or nearly so) and the said plane is substantially parallel to the heel-toe axis of the putter-head. The main variable with this type of swing is the position of the ball in relation to the vertical arc path of the putter-head. Preferably the ball is positioned such that impact occurs at or just beyond the bottom of the arc (on the upward part of the arc), but may otherwise be positioned either side of this range.

Figure 5a shows an example of impact at the bottom of the arc, where the putter-head trajectory is horizontal (shown by arrow symbol 18a). Here, impact generally occurs at mid-height to upper part of the impact face. With impacts at this ball position the height of contact on the ball depends only on the loft angle α_{MAX} provided that the clearance 19a between the putting surface 14 and the sole 6 is not more than the ball radius less the height of the convex curved lower half 17 of the impact-face. With ground-to-sole clearance greater than this, the height of contact will increase and may disadvantageously rise above the horizontal equator of the ball 13 and consequently launch the ball with a slight negative elevation trajectory. This type of putting stroke is rare except with players of less than moderate skill and typifies poor putter control. Nevertheless it is preferred that negative

ball trajectory is avoided by providing that the region on the impact-face where the loft is negative is limited to the lower 12 millimetres or more preferably the lower 9 millimetres.

Figure 5b shows an example of impact at a point beyond the bottom of the pendulum arc where the putter-head trajectory (depicted by arrow symbol 18b) has positive elevation. In this instance the ball launch trajectory is dependent on the combination of trajectory elevation angle and the loft angle at impact, which is generally slightly negative and varies both with the ground clearance 19b and the elevation angle of the trajectory 18b. Provided the sum of putter-head trajectory angle and loft angle at impact point is greater than -20% of the trajectory elevation angle, the ball launch elevation angle will be positive. Thus the ball is still given a slight lift for impacts in the lower (negative loft) region of the impact-face provided the bottom of the pendulum arc is kept low as before.

The aim of the present invention is to provide a putter that imparts topspin on the ball from all pendulum swing putts and also maximises the probability of imparting positive lift on the ball at impact. It is known that two mechanisms impart spin with club-on-ball impact in golf, namely eccentric impact (commonly known as 'gear-effect') and oblique impact, which is most commonly experienced as backspin due to clubface loft.

The gear-effect realised with a putter-head is dependent on the condition that the line of impact (i.e. the line normal to the impact surfaces at the point of impact) is offset from the centre of mass of the head. It follows that the condition for gear-effect in the present invention is also dependent on the impact face loft angle at the point of impact. We define h (the offset distance between the line of impact and h_c) as follows:

$$h = h_i - h_c - p \times \sin(\alpha_i) \quad \ldots(1)$$

where h_i is the height (millimetres) of the impact point measured above the bottom-most part of the putter-head and α_i (degrees) is the putter face loft angle at the point of impact, taken as positive for upward tilt.

The value of spin attainable with gear-effect is known from Newtonian dynamics assuming that the putter-head and golf ball behave as free rigid bodies at impact and is given by:

$$S_G = \frac{250 \times p \times h}{(3.2 + 70 \times M) \times K^2 + p^2} \quad (2)$$

where M is the putter-head mass (kilograms), K is the radius of gyration for rotation about the horizontal heel-toe axis through the centre of mass (millimetres) and S_G is the ratio of the ball's peripheral velocity due to rotation to its linear or translational velocity (percent).

For vertical gear effect to impart topspin rather than backspin, the value of h must be positive. This is exemplified in Figure 5a where the line of impact 20a (collinear with the centre of the ball 13 and the impact point) passes above the centre of mass 15.

With pendulum swing putts the putter-head elevation trajectory is always parallel to the sole 6 and therefore the spin imparted due to oblique impact is a function of the impact-face loft α_i but not trajectory, and is given by:

$$S_L = \frac{0.76 \times (-\alpha_i)}{1 + 0.04 \times (p/K)^2} \quad (3)$$

where S_L denotes the percentage spin (defined as for S_G) as a function of loft. Note that positive loft imparts negative spin or backspin and negative loft imparts topspin. Conveniently, it is practical to provide negative loft, which in turn imparts topspin, in the lower half 17 of the impact-face and this compensates for the fact that h defined in Equation 1 normally becomes negative for small values of h_1. This is depicted in Figure 5b where the line of impact 20b is shown to pass below the centre of mass 15.

The value of h can in practice be kept positive even for zero h_1 by arranging $[h_c - p \times sin(\alpha_1]$ to remain positive. However, this option requires severely negative loft, especially for smaller values of p and thus undesirably imparts negative ball launch trajectory rather than the desired lift.

It is thus much more preferable to arrange that the sum of S_L and S_G is positive at least for putts above the lower limit of useful impact height, e.g. above 5 millimetres and it is preferable that the minimum spin rate is at least +2.5% or more preferably +5.0% in this range. However, it may be desirable to extend the range so that any impact, even at nominal zero impact height, imparts topspin and that the spin rate from a pendulum stroke on any part of the impact-face is at least 2.5%.

It can be seen from Equations 1 to 3 that a number of putter-head parameters determine spin rate, namely p, h_c, M, K and α_1 (which is a function of impact height). In the putter-head design of Figures 1 to 4 typical value ranges are as follows:

p	16 to 22
h_c	6 to 8

M 0.3 to 0.35

K 10 to 12

These value ranges are appropriate for blade style putters but for mallet style putters the values for p and K are generally larger. Having selected the above parameters, the impact-face profile is then designed to obtain the requisite minimum spin rate, which normally corresponds to the lowest impact height of interest (e.g. 5 millimetres or nominally zero), and also the requisite spin rates and/or relative launch velocities at other impact heights. Preferably the negative loft on any part of the impact-face should be not less than -15 degrees but more preferably no less than -10 degrees. Table I below gives an example of a design based on Figures 1 to 4.

Table I

p = 20 millimetres
h_c = 7 millimetres
M = 0.31 kilograms
K = 10.5 millimetres
α_{MAX} = 2.0 deg (h_i > 11.5 mm)

h_i (mm)	α_i (deg)	S_G (%)	S_L (%)	$S_G + S_L$ (%)
0	-9.95	-5.64	+6.60	+1
5	-4.69	-0.58	+3.12	+2.5
12	+2.0	+6.84	-1.33	+5.5

It is found in practice that the position of the shaft hosel 7 has a strong influence on the putter-head rotation about the heel-toe axis during the very short duration of impact (less than one millisecond). This is especially the case where the moment of inertia about the heel-toe axis is relatively small, which is a necessary condition for imparting significant topspin.

Assuming that the horizontal offset between the shaft attachment axis and the heel-toe axis has value *d* and that the vertical offset between the shaft point of attachment and the heel-toe axis has value *d2*, it has been proved experimentally that with both *d* zero and *d2* zero or negative topspin performance is enhanced, whereas increasing either *d* or *d2* reduces the imparted topspin and also reduces the variation in launch velocity as a function of impact height. Thus, there is empirical evidence that if either *d* or *d2* are greater than zero the effective radius of gyration K_e is greater than the basic putter-head radius of gyration *K* (both measured about the heel-toe axis through the putter-head centre of mass). It follows that the ratios *d/K* and *d2/K* are important design factors. It is considered that *d/K* should be less than +1.0 or more preferably, less than +0.33. Similarly, *d2/K* should be less than +1.0 or more preferably, less than +0.33. However where *K* is large (as in mallet style putters) it is also preferable to have *d* less than *r* where *r* is the radius of the putter shaft.

A further advantage of positioning the shaft coupling close to the centre of mass is that shaft vibrations due to eccentric impact are minimised. In this respect, it is advantageous that the axis of the shaft attachment means passes close (preferably not more than *K* millimetres) to the putter-head centre of mass (as distinct from the heel-toe axis through this centre).

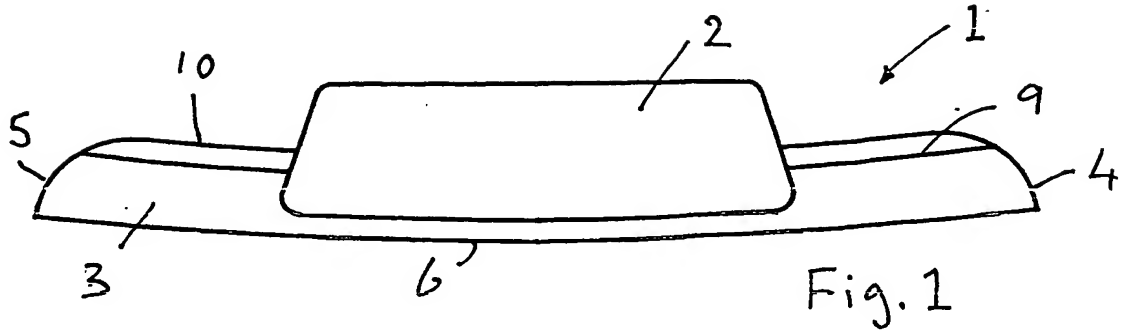

Fig. 1

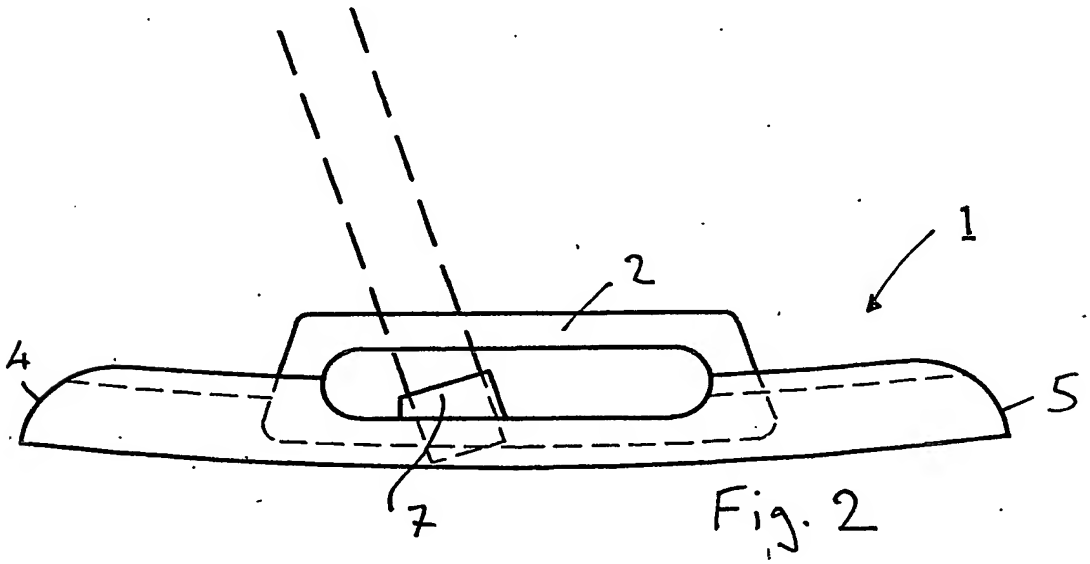

Fig. 2

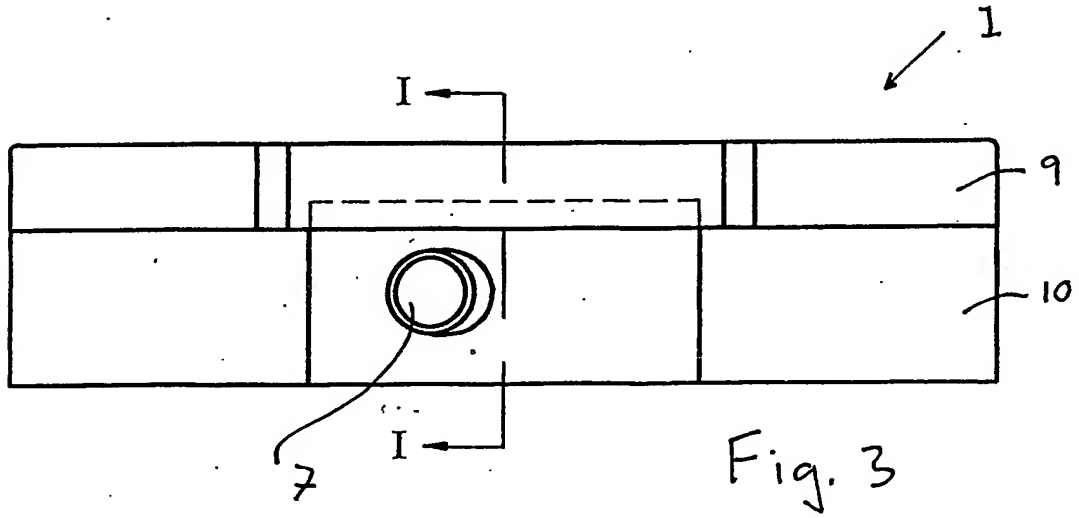

Fig. 3

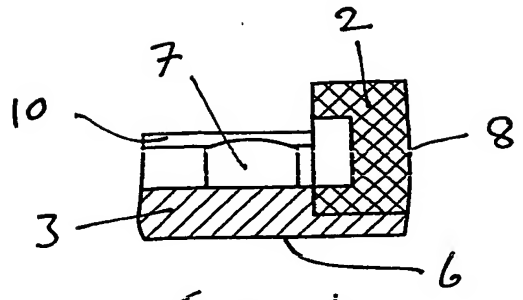

Fig. 4

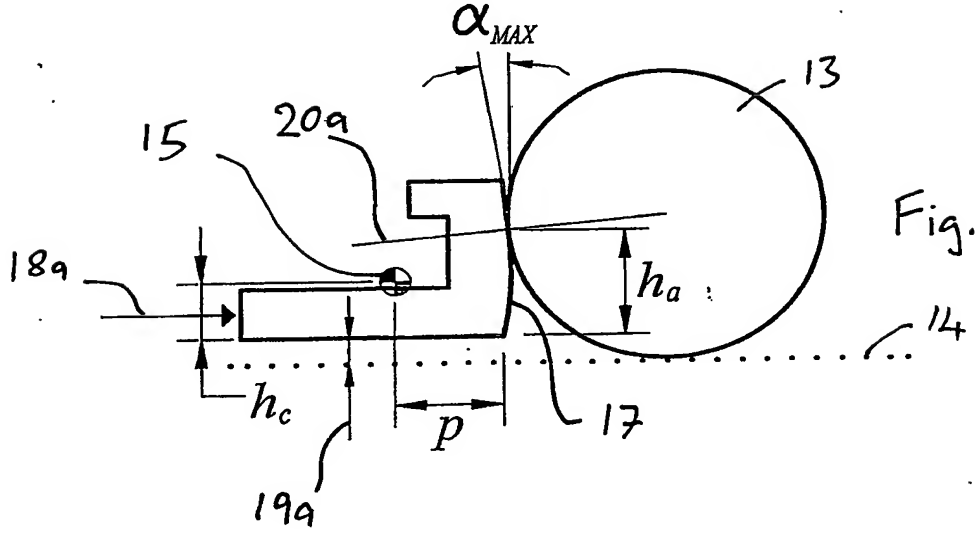

Fig. 5a

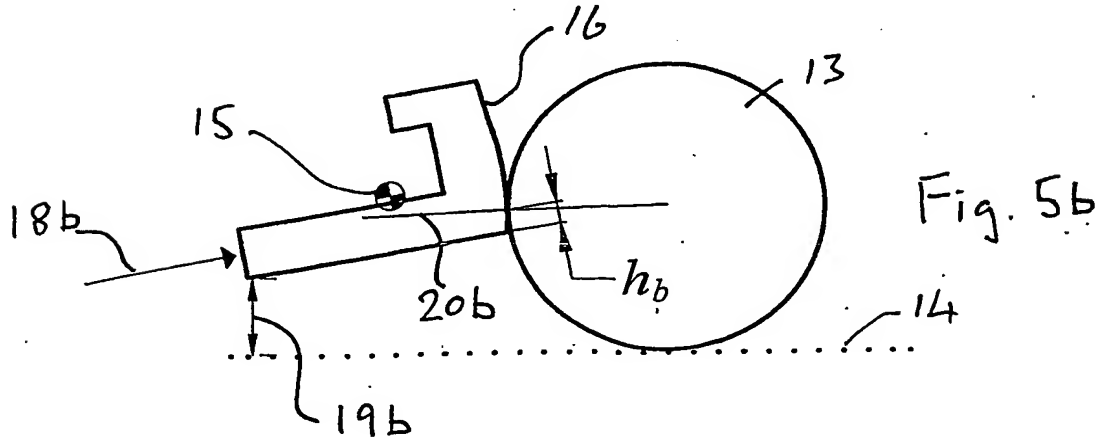

Fig. 5b

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